Photographic Measures of the Ring Nebula in Lyra and of the Neighbouring Faint Stars. By F. P. Leavenworth.

(*Communicated by the Secretaries.*)

In response to Professor Barnard's request for observations of the faint stars near the Ring Nebula of *Lyra* (see *Monthly Notices, R.A.S.*, January 1900), the following measurements are published. They are measures of photographs taken with the 10½-inch refractor of the University of Minnesota.

Observations of position-angle and distance were made with a Repsold measuring machine, exactly as a double star is measured with a filar micrometer or an ordinary visual telescope. Each measure was repeated with the angle rotated through 180°.

The orientation was found by reading the angle of a star trail on the plate.

Since the distances measured were very small, never more than one and one-half millimetres, variation of scale value and other small corrections were found to be negligible quantities. The amount of time consumed in measurement and reduction was therefore not greatly in excess of that employed in ordinary double-star measures.

Corrections were applied for division error of scale, error of run and refraction. In addition a correction to the reading of the circle for orientation had to be introduced because the trail was not at the middle of the plate. If c = this correction and d = the distance of the trail from the middle of the plate,

$$c = d \tan \delta$$

plus if the trail is east. The greatest value of c was about 0°·5.

The adopted scale value for all four plates was one millimetre = 59″·64.

The plates were taken as follows :—

		h	m	
I. Sept. 1, 1897	Exposure	1	23	Night poor.
II. Nov. 1, 1899	,,	2	4	,, fair.
III. Apr. 1, 1900	,,	1	42	,, good.
IV. June 5, ,,	,,	2	5	,, good.

The nucleus of the nebula was a clearly defined spot which could be accurately measured. Star *b* was too indistinct to be observed except on plate 2, and *c* was scarcely stronger ; *f* could not be accurately measured on account of the blurring of the components.

Plate III. was measured by three members of the class in astronomy, Miss Harriet Dunton, Miss Louise Goulding, and Mr. Albert Lehman. Their names are indicated by the initials D., G., L. This being their first experience in photographic

measurements, each made a complete set of measures of the same plate. For this reason the separate results are given; and also to show what accuracy may be expected from measures repeated on the same plate. Plates I., II., and IV. were measured by myself.

The probable errors are $\pm 0^{\circ}.14$ and $\pm 0''.18$ for the values of a position-angle and distance from a single plate.

Measures of Plate III.

	Nucleus and *a*.			*a* and *d*.	
	°	″		°	″
D.	88·98	60·65	D.	286·47	137·18
G.	89·24	60·30	G.	286·47	137·66
L.	89·54	59·76	L.	286·44	137·46
	Nucleus and *d*.			*a* and *e*.	
D.	299·38	82·07	D.	292·82	122·25
G.	299·47	81·93	G.	292·76	122·25
L.	299·70	81·57	L.	292·75	122·29
	Nucleus and *e*.			*a* and *g*.	
D.	312·88	71·71	D.	350·76	75·78
G.	313·25	71·71	G.	350·62	77·02
L.	312·57	70·85	L.	350·39	76·64
	Nucleus and *g*.			*a* and *h*.	
D.	32·72	90·27	D.	148·47	70·45
G.	33·13	90·25	G.	148·69	70·60
	Nucleus and *h*.		L.	148·50	70·56
D.	121·08	113·70			
G.	121·50	113·93			

Nucleus and *a*.

	°	″
1897·671	89·48	60·42
1899·837	89·35	60·83
1900·248	89·25	60·24
1900·428	89·10	60·73
1899·55	89·29	60·56

Nucleus and *b*.

1899·837	186·61	65·17

Nucleus and *c*.

1899·837	268·12	55·12
1900·428	269·53*	55·56*
1900·13	268·82	55·34

* Image double.

Nucleus and *d*.

1899·837	299°86	81″74
1900·248	299·52	81·86
1900·428	299·95	82·31
1900·17	299·78	81·97

Nucleus and *e*.

1897·671	312·62	71·66
1899·837	313·04	71·16
1900·248	312·90	71·32
1900·428	312·65	71·12
1899·55	312·80	71·32

Nucleus and *g*.

1899·837	32·49	89·59
1900·248	32·72	90·26
1900·428	32·10	90·53
1900·17	32·50	90·13

Nucleus and *h*.

1897·671	121·12	113·67
1899·837	121·08	114·12
1900·248	121·29	113·82
1900·428	121·23	113·74
1899·55	121·18	113·84

a and *b*.

1899·837	225·57	94·38

a and *c*.

1899·837	268·63	115·38
1900·428	268·63	115·72
1900·13	268·63	115·55

a and *d*.

1899·837	286·90	137·14
1900·248	286·46	137·43
1900·428	286·91	137·74
1900·17	286·76	137·44

a and *e*.

1897·671	292°·60	122″·88
1899·837	292·88	122·14
1900·248	292·78	122·26
1900·428	292·57	122·20
1899·55	292·71	122·37

a and *g*.

1899·837	350·14	76·12
1900·248	350·59	76·48
1900·428	350·22	76·78
1900·17	350·32	76·46

a and *h*.

1897·671	148·54	70·41
1899·837	148·70	70·50
1900·248	148·56	70·54
1900·428	148·57	70·24
1899·55	148·59	70·42

Considering the great difference in the size of the telescopes, in the methods used, and in the difficulty of the objects measured, the agreement with Professor Barnard's measures is very good, and confirms his results. There is without doubt a difference of 1°·4 and 1″ between Burnham's measures of the nucleus and *a* and the present value. And it seems very probable that there is motion in one of these objects.

The complete list of measures of nucleus and *a* are as follows :—

Burnham	1891·45	87°·8	61″·69	5
Scheiner	1894·83	89·07	60·85	1
Barnard	1898·60	88·77	60·70	5
„	1899·48	89·14	60·66	5
Leavenworth	1899·55	89·29	60·56	4

In a letter to the writer Professor Barnard has corrected the values of his distances, having obtained a better value of a revolution of the micrometer screw ; and in Dr. Scheiner's measure I have, at Professor Barnard's request, used only the measure made by the former.

The magnitudes of the stars were determined by the sequence method. When compared with Professor Barnard's values

(*Monthly Notices* vol. lx. p. 248), and reduced by them to magnitudes, a very close agreement is obtained, as appears below :—

Star	Step.	Mag. B.	Mag. L.
a	0	12·2	12·2
h	25	12·8	13·1
n	27	...	13·1
e	28	13·2	13·2
f	40	13·7	13·6
g	43	13·7	13·7
d	44	13·5	13·8
c	49	14·0	14·0
b	52	13·8	14·1

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1900 *September.*

Observations of Nebulæ made at the Chamberlin Observatory, University Park, Colorado. By Herbert A. Howe.

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The accompanying notes on nebulæ are a by-product of the series of measurements made with the Bruce micrometer on the 20-inch equatorial refractor, during the twelve months ending 1900 June 30. They are corrections of or additions to our previous information, and form a continuation of the notes published in former numbers of the *Monthly Notices*, the last being in the issue for 1899 December. When the position of a nebula is given below it is to be understood that the position previously published in the N.G.C. or *Index Catalogue*, or in some later list sent out by the discoverer, is erroneous by at least ten seconds in right ascension or two minutes in declination. Usually the errors are much larger than these. All positions are referred to the mean equinox of 1900·0.

It has seemed best to divide the nebulæ mentioned into three lists. The first contains those found in the N.G.C., arranged in the order of their current numbers. The second list is made up from the *Index Catalogue*. All nebulæ taken from it have their current numbers enclosed in brackets, to distinguish them from those in the N.G.C. The third list consists of nebulæ found by Swift at the Lowe Observatory in recent years. All but one of them are found in *A.N.* 3517, and are designated by affixing their current numbers in that publication to the word Swift. The one exception, which I have called "Swift 12, 3," is taken from the *Monthly Notices*, vol. lix. No. 10, p. 568. The words "minutes" and "seconds" refer to time only. A few of the notes are about clusters which have been examined.